```
#|

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|#
```

EVENT: Start with the library "mc20-2" using the compiled version.

```
;          Proof of the Correctness of the STRNCPY Function
#|
This is part of our effort to verify the Berkeley string library.  The
Berkeley string library is widely used as part of the Berkeley Unix OS.

This is the source code of strncpy function in the Berkeley string library.

char *
strncpy(dst, src, n)
char *dst;
const char *src;
register size_t n;
{
if (n != 0) {
register char *d = dst;
register const char *s = src;
```

```
do {
if ((*d++ = *s++) == 0) {
/* NUL pad the remaining n-1 bytes */
while (--n != 0)
*d++ = 0;
break;
}
} while (--n != 0);
}
return (dst);
}
```

The MC68020 assembly code of the C function strncpy on SUN-3 is given as follows. This binary is generated by "gcc -O".

```
0x2650 <strncpy>:       linkw fp,#0
0x2654 <strncpy+4>:     movel d2,sp@-
0x2656 <strncpy+6>:     movel fp@(8),d2
0x265a <strncpy+10>:    movel fp@(16),d1
0x265e <strncpy+14>:    beq 0x267a <strncpy+42>
0x2660 <strncpy+16>:    moveal d2,a0
0x2662 <strncpy+18>:    moveal fp@(12),a1
0x2666 <strncpy+22>:    moveb a1@+,d0
0x2668 <strncpy+24>:    moveb d0,a0@+
0x266a <strncpy+26>:    bne 0x2676 <strncpy+38>
0x266c <strncpy+28>:    bra 0x2670 <strncpy+32>
0x266e <strncpy+30>:    clrb a0@+
0x2670 <strncpy+32>:    subl #1,d1
0x2672 <strncpy+34>:    bne 0x266e <strncpy+30>
0x2674 <strncpy+36>:    bra 0x267a <strncpy+42>
0x2676 <strncpy+38>:    subl #1,d1
0x2678 <strncpy+40>:    bne 0x2666 <strncpy+22>
0x267a <strncpy+42>:    movel d2,d0
0x267c <strncpy+44>:    movel fp@(-4),d2
0x2680 <strncpy+48>:    unlk fp
0x2682 <strncpy+50>:    rts
```

The machine code of the above program is:

```
<strncpy>:     0x4e56  0x0000  0x2f02  0x242e  0x0008  0x222e  0x0010  0x671a
<strncpy+16>:  0x2042  0x226e  0x000c  0x1019  0x10c0  0x660a  0x6002  0x4218
<strncpy+32>:  0x5381  0x66fa  0x6004  0x5381  0x66ec  0x2002  0x242e  0xfffc
<strncpy+48>:  0x4e5e  0x4e75
```

```
'(78      86      0       0       47      2       36      46
  0       8       34      46      0       16      103     26
  32      66      34      110     0       12      16      25
  16      192     102     10      96      2       66      24
  83      129     102     250     96      4       83      129
  102     236     32      2       36      46      255     252
  78      94      78      117)
|#
; in the logic, the above program is defined by (strncpy-code).
```

DEFINITION:
STRNCPY-CODE
= `'(78 86 0 0 47 2 36 46 0 8 34 46 0 16 103 26 32 66 34 110 0 12 16 25 16 192 102 10 96 2 66 24 83 129 102 250 96 4 83 129 102 236 32 2 36 46 255 252 78 94 78 117)`

`; the computation time of the program.`

DEFINITION:
strncpy-t0 (i, n)
= **if** $(n - 1) =$ `0` **then** `7`
else splus (`3`, strncpy-t0 $(1 + i, n - 1)$) **endif**

DEFINITION: strncpy-t1 (i, n) = splus (`4`, strncpy-t0 $(1 + i, n)$)

DEFINITION:
strncpy-t2 (i, n, *lst2*)
= **if** get-nth (i, *lst2*) = `0` **then** strncpy-t1 (i, n)
elseif $(n - 1) =$ `0` **then** `9`
else splus (`5`, strncpy-t2 $(1 + i, n - 1,$ *lst2*)) **endif**

DEFINITION:
strncpy-t (n, *lst2*)
= **if** $n \simeq$ `0` **then** `9`
else splus (`7`, strncpy-t2 (`0`, n, *lst2*)) **endif**

`; two induction hints.`

DEFINITION:
strncpy-induct1 (s, i^*, i, n, *lst1*)
= **if** $(n - 1) =$ `0` **then t**
else strncpy-induct1 (stepn (s, `3`),
add (`32`, i^*, `1`),
$1 + i$,
$n - 1$,
put-nth (`0`, i, *lst1*)) **endif**

DEFINITION:
strncpy-induct2 (s, $i*$, i, n, *lst1*, *lst2*)
= **if** get-nth (i, *lst2*) = `0` **then t**
elseif (n − 1) = `0` **then t**
else strncpy-induct2 (stepn (s, `5`),
add (`32`, $i*$, `1`),
1 + i,
n − 1,
put-nth (get-nth (i, *lst2*), i, *lst1*),
lst2) **endif**

```
; the preconditions of the initial state.
```

DEFINITION:
strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*)
= ((mc-status (s) = `'running`)
∧ evenp (mc-pc (s))
∧ rom-addrp (mc-pc (s), mc-mem (s), `52`)
∧ mcode-addrp (mc-pc (s), mc-mem (s), STRNCPY-CODE)
∧ ram-addrp (sub (`32`, `8`, read-sp (s)), mc-mem (s), `24`)
∧ ram-addrp (*str1*, mc-mem (s), n)
∧ mem-lst (`1`, *str1*, mc-mem (s), n, *lst1*)
∧ ram-addrp (*str2*, mc-mem (s), *n2*)
∧ mem-lst (`1`, *str2*, mc-mem (s), *n2*, *lst2*)
∧ disjoint (sub (`32`, `8`, read-sp (s)), `24`, *str1*, n)
∧ disjoint (sub (`32`, `8`, read-sp (s)), `24`, *str2*, *n2*)
∧ disjoint (*str1*, n, *str2*, *n2*)
∧ (slen (`0`, n, *lst2*) < *n2*)
∧ (*str1* = read-mem (add (`32`, read-sp (s), `4`), mc-mem (s), `4`))
∧ (*str2* = read-mem (add (`32`, read-sp (s), `8`), mc-mem (s), `4`))
∧ (n = uread-mem (add (`32`, read-sp (s), `12`), mc-mem (s), `4`))
∧ (*n2* ∈ **N**))

```
; an intermediate state s0.
```

DEFINITION:
strncpy-s0p (s, $i*$, i, *str1*, $n_$, *lst1*, *str2*, *n2*, *lst2*, n)
= ((mc-status (s) = `'running`)
∧ evenp (mc-pc (s))
∧ rom-addrp (sub (`32`, `22`, mc-pc (s)), mc-mem (s), `52`)
∧ mcode-addrp (sub (`32`, `22`, mc-pc (s)), mc-mem (s), STRNCPY-CODE)
∧ ram-addrp (sub (`32`, `4`, read-an (`32`, `6`, s)), mc-mem (s), `24`)
∧ ram-addrp (*str1*, mc-mem (s), $n_$)
∧ mem-lst (`1`, *str1*, mc-mem (s), $n_$, *lst1*)
∧ ram-addrp (*str2*, mc-mem (s), *n2*)

$\wedge$ mem-lst (1, *str2*, mc-mem (*s*), *n2*, *lst2*)
$\wedge$ disjoint (sub (32, 4, read-an (32, 6, *s*)), 24, *str1*, $n_{\_}$)
$\wedge$ disjoint (sub (32, 4, read-an (32, 6, *s*)), 24, *str2*, *n2*)
$\wedge$ disjoint (*str1*, $n_{\_}$, *str2*, *n2*)
$\wedge$ (slen (*i*, $n_{\_}$, *lst2*) $<$ *n2*)
$\wedge$ equal* (read-an (32, 0, *s*), add (32, *str1*, i^*))
$\wedge$ equal* (read-an (32, 1, *s*), add (32, *str2*, i^*))
$\wedge$ (*str1* = read-dn (32, 2, *s*))
$\wedge$ (n = nat-to-uint (read-dn (32, 1, *s*)))
$\wedge$ ((i + n) $\leq$ $n_{\_}$)
$\wedge$ ($n \neq 0$)
$\wedge$ ($i^* \in \mathbf{N}$)
$\wedge$ nat-rangep (i^*, 32)
$\wedge$ (i = nat-to-uint (i^*))
$\wedge$ (*n2* $\in \mathbf{N}$)
$\wedge$ ($n_{\_} \in \mathbf{N}$)
$\wedge$ uint-rangep ($n_{\_}$, 32))

; an intermediate state s1.

DEFINITION:
strncpy-s1p (*s*, i^*, *i*, *str1*, $n_{\_}$, *lst1*, *str2*, *n2*, *lst2*, *n*)
= ((mc-status (*s*) = 'running)
$\wedge$ evenp (mc-pc (*s*))
$\wedge$ rom-addrp (sub (32, 32, mc-pc (*s*)), mc-mem (*s*), 52)
$\wedge$ mcode-addrp (sub (32, 32, mc-pc (*s*)), mc-mem (*s*), STRNCPY-CODE)
$\wedge$ ram-addrp (sub (32, 4, read-an (32, 6, *s*)), mc-mem (*s*), 24)
$\wedge$ ram-addrp (*str1*, mc-mem (*s*), $n_{\_}$)
$\wedge$ mem-lst (1, *str1*, mc-mem (*s*), $n_{\_}$, *lst1*)
$\wedge$ ram-addrp (*str2*, mc-mem (*s*), *n2*)
$\wedge$ mem-lst (1, *str2*, mc-mem (*s*), *n2*, *lst2*)
$\wedge$ disjoint (sub (32, 4, read-an (32, 6, *s*)), 24, *str1*, $n_{\_}$)
$\wedge$ disjoint (sub (32, 4, read-an (32, 6, *s*)), 24, *str2*, *n2*)
$\wedge$ disjoint (*str1*, $n_{\_}$, *str2*, *n2*)
$\wedge$ equal* (read-an (32, 0, *s*), add (32, *str1*, i^*))
$\wedge$ (*str1* = read-dn (32, 2, *s*))
$\wedge$ (n = nat-to-uint (read-dn (32, 1, *s*)))
$\wedge$ (i = nat-to-uint (i^*))
$\wedge$ ((i + (n $-$ 1)) $\leq$ $n_{\_}$)
$\wedge$ ($n \neq 0$)
$\wedge$ ($i^* \in \mathbf{N}$)
$\wedge$ nat-rangep (i^*, 32)
$\wedge$ (*n2* $\in \mathbf{N}$)
$\wedge$ ($n_{\_} \in \mathbf{N}$)
$\wedge$ uint-rangep ($n_{\_}$, 32))

```
; from the initial state s to exit: s --> sn, when n = 0.
```

THEOREM: strncpy-s-sn
(strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*) $\wedge$ ($n \simeq$ 0))
$\rightarrow$ ((mc-status (stepn (s, 9)) = 'running)
$\wedge$ (mc-pc (stepn (s, 9)) = rts-addr (s))
$\wedge$ (read-dn (32, 0, stepn (s, 9)) = *str1*)
$\wedge$ mem-lst (1, *str1*, mc-mem (stepn (s, 9)), n, *lst1*)
$\wedge$ (read-rn (32, 15, mc-rfile (stepn (s, 9)))
= add (32, read-an (32, 7, s), 4))
$\wedge$ (read-rn (32, 14, mc-rfile (stepn (s, 9))) = read-an (32, 6, s)))

THEOREM: strncpy-s-sn-rfile
(strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*)
$\wedge$ ($n \simeq$ 0)
$\wedge$ (*oplen* $\leq$ 32)
$\wedge$ d2-7a2-5p (*rn*))
$\rightarrow$ (read-rn (*oplen*, *rn*, mc-rfile (stepn (s, 9)))
= read-rn (*oplen*, *rn*, mc-rfile (s)))

THEOREM: strncpy-s-sn-mem
(strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*)
$\wedge$ ($n \simeq$ 0)
$\wedge$ disjoint (x, k, sub (32, 8, read-sp (s)), 24))
$\rightarrow$ (read-mem (x, mc-mem (stepn (s, 9)), k) = read-mem (x, mc-mem (s), k))

```
; from the initial state s to s0: s --> s0.
```

THEOREM: strncpy-s-s0
(strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*) $\wedge$ ($n \not\simeq$ 0))
$\rightarrow$ strncpy-s0p (stepn (s, 7), 0, 0, *str1*, n, *lst1*, *str2*, *n2*, *lst2*, n)

THEOREM: strncpy-s-s0-else
(strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*) $\wedge$ ($n \not\simeq$ 0))
$\rightarrow$ ((linked-rts-addr (stepn (s, 7)) = rts-addr (s))
$\wedge$ (linked-a6 (stepn (s, 7)) = read-an (32, 6, s))
$\wedge$ (read-rn (32, 14, mc-rfile (stepn (s, 7)))
= sub (32, 4, read-sp (s)))
$\wedge$ (rn-saved (stepn (s, 7)) = read-rn (32, 2, mc-rfile (s))))

THEOREM: strncpy-s-s0-rfile
(strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*) $\wedge$ ($n \not\simeq$ 0) $\wedge$ d3-7a2-5p (*rn*))
$\rightarrow$ (read-rn (*oplen*, *rn*, mc-rfile (stepn (s, 7)))
= read-rn (*oplen*, *rn*, mc-rfile (s)))

THEOREM: strncpy-s-s0-mem
(strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*)
 $\wedge$ ($n \not\simeq$ 0)
 $\wedge$ disjoint (x, k, sub (32, 8, read-sp (s)), 24))
$\rightarrow$ (read-mem (x, mc-mem (stepn (s, 7)), k) = read-mem (x, mc-mem (s), k))

```
; from s0 to exit: s0 --> sn.  By induction.
; base case 1:  s0 --> sn, when lst1[i] = 0.
; s0 --> s1.
```

THEOREM: strncpy-s0-s1
(strncpy-s0p (s, i*, i, *str1*, $n_{\_}$, *lst1*, *str2*, *n2*, *lst2*, n)
 $\wedge$ (get-nth (i, *lst2*) = 0))
$\rightarrow$ (strncpy-s1p (stepn (s, 4),
                add (32, i*, 1),
                1 + i,
                str1,
                $n_{\_}$,
                put-nth (get-nth (i, *lst2*), i, *lst1*),
                str2,
                n2,
                lst2,
                n)
    $\wedge$ (linked-rts-addr (stepn (s, 4)) = linked-rts-addr (s))
    $\wedge$ (linked-a6 (stepn (s, 4)) = linked-a6 (s))
    $\wedge$ (read-rn (32, 14, mc-rfile (stepn (s, 4)))
        = read-rn (32, 14, mc-rfile (s)))
    $\wedge$ (rn-saved (stepn (s, 4)) = rn-saved (s)))

THEOREM: strncpy-s0-s1-rfile
(strncpy-s0p (s, i*, i, *str1*, $n_{\_}$, *lst1*, *str2*, *n2*, *lst2*, n)
 $\wedge$ (get-nth (i, *lst2*) = 0)
 $\wedge$ d3-7a2-5p (rn))
$\rightarrow$ (read-rn (*oplen*, rn, mc-rfile (stepn (s, 4)))
    = read-rn (*oplen*, rn, mc-rfile (s)))

THEOREM: strncpy-s0-s1-mem
(strncpy-s0p (s, i*, i, *str1*, $n_{\_}$, *lst1*, *str2*, *n2*, *lst2*, n)
 $\wedge$ (get-nth (i, *lst2*) = 0)
 $\wedge$ disjoint (x, k, *str1*, $n_{\_}$))
$\rightarrow$ (read-mem (x, mc-mem (stepn (s, 4)), k) = read-mem (x, mc-mem (s), k))

```
; s1 --> sn.  By induction.
; base case: s1 --> exit, when n-1 = 0.
```

THEOREM: strncpy-s1-sn-base
(strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*) ∧ ((*n* − 1) = 0))
→ ((mc-status (stepn (*s*, 7)) = 'running)
∧ (mc-pc (stepn (*s*, 7)) = linked-rts-addr (*s*))
∧ (read-dn (32, 0, stepn (*s*, 7)) = *str1*)
∧ mem-lst (1, *str1*, mc-mem (stepn (*s*, 7)), *n_*, *lst1*)
∧ (read-rn (32, 14, mc-rfile (stepn (*s*, 7))) = linked-a6 (*s*))
∧ (read-rn (32, 15, mc-rfile (stepn (*s*, 7)))
= add (32, read-an (32, 6, *s*), 8))
∧ (read-mem (*x*, mc-mem (stepn (*s*, 7)), *k*)
= read-mem (*x*, mc-mem (*s*), *k*)))

THEOREM: strncpy-s1-sn-rfile-base
(strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*)
∧ ((*n* − 1) = 0)
∧ (*oplen* ≤ 32)
∧ d2-7a2-5p (*rn*))
→ (read-rn (*oplen*, *rn*, mc-rfile (stepn (*s*, 7)))
= **if** d3-7a2-5p (*rn*) **then** read-rn (*oplen*, *rn*, mc-rfile (*s*))
else head (rn-saved (*s*), *oplen*) **endif**)

```
; induction case: s1 --> s1, when n-1 =\= 0.
```

THEOREM: strncpy-s1-s1
(strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*) ∧ ((*n* − 1) ≠ 0))
→ (strncpy-s1p (stepn (*s*, 3),
add (32, *i**, 1),
1 + *i*,
str1,
*n_*,
put-nth (0, *i*, *lst1*),
str2,
n2,
lst2,
n − 1)
∧ (read-rn (32, 14, mc-rfile (stepn (*s*, 3)))
= read-rn (32, 14, mc-rfile (*s*)))
∧ (linked-a6 (stepn (*s*, 3)) = linked-a6 (*s*))
∧ (linked-rts-addr (stepn (*s*, 3)) = linked-rts-addr (*s*))
∧ (rn-saved (stepn (*s*, 3)) = rn-saved (*s*)))

THEOREM: strncpy-s1-s1-rfile
(strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*)
∧ ((*n* − 1) ≠ 0)
∧ d3-7a2-5p (*rn*))

→ (read-rn (*oplen*, *rn*, mc-rfile (stepn (*s*, 3)))
= read-rn (*oplen*, *rn*, mc-rfile (*s*)))

THEOREM: strncpy-s1-s1-mem
(strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*)
∧ disjoint (*x*, *k*, *str1*, *n_*)
∧ ((*n* − 1) ≠ 0))
→ (read-mem (*x*, mc-mem (stepn (*s*, 3)), *k*) = read-mem (*x*, mc-mem (*s*), *k*))

```
; put together. s1 --> exit.
```

THEOREM: strncpy-s1-sn
let *sn* **be** stepn (*s*, strncpy-t0 (*i*, *n*))
in
strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*)
→ ((mc-status (*sn*) = 'running)
∧ (mc-pc (*sn*) = linked-rts-addr (*s*))
∧ (read-dn (32, 0, *sn*) = *str1*)
∧ mem-lst (1, *str1*, mc-mem (*sn*), *n_*, zero-list1 (*i*, *n*, *lst1*))
∧ (read-rn (32, 14, mc-rfile (*sn*)) = linked-a6 (*s*))
∧ (read-rn (32, 15, mc-rfile (*sn*))
= add (32, read-an (32, 6, *s*), 8))) **endlet**

THEOREM: strncpy-s1-sn-rfile
(strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*)
∧ (*oplen* ≤ 32)
∧ d2-7a2-5p (*rn*))
→ (read-rn (*oplen*, *rn*, mc-rfile (stepn (*s*, strncpy-t0 (*i*, *n*))))
= **if** d3-7a2-5p (*rn*) **then** read-rn (*oplen*, *rn*, mc-rfile (*s*))
else head (rn-saved (*s*), *oplen*) **endif**)

THEOREM: strncpy-s1-sn-mem
(strncpy-s1p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*) ∧ disjoint (*x*, *k*, *str1*, *n_*))
→ (read-mem (*x*, mc-mem (stepn (*s*, strncpy-t0 (*i*, *n*))), *k*)
= read-mem (*x*, mc-mem (*s*), *k*))

```
; put together (base case 1). s0 --> exit.
```

THEOREM: strncpy-s0-sn-base1
let *sn* **be** stepn (*s*, strncpy-t1 (*i*, *n*))
in
(strncpy-s0p (*s*, *i**, *i*, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, *n*)
∧ (get-nth (*i*, *lst2*) = 0))
→ ((mc-status (*sn*) = 'running)
∧ (mc-pc (*sn*) = linked-rts-addr (*s*))

$\wedge$ (read-dn (32, 0, *sn*) = *str1*)
$\wedge$ mem-lst (1, *str1*, mc-mem (*sn*), *n*_, zero-list (*i*, *n*, *lst1*))
$\wedge$ (read-rn (32, 14, mc-rfile (*sn*)) = linked-a6 (*s*))
$\wedge$ (read-rn (32, 15, mc-rfile (*sn*))
= add (32, read-an (32, 6, *s*), 8))) **endlet**

THEOREM: strncpy-s0-sn-rfile-base1
(strncpy-s0p (*s*, *i**, *i*, *str1*, *n*_, *lst1*, *str2*, *n2*, *lst2*, *n*)
$\wedge$ (get-nth (*i*, *lst2*) = 0)
$\wedge$ (*oplen* $\leq$ 32)
$\wedge$ d2-7a2-5p (*rn*))
$\rightarrow$ (read-rn (*oplen*, *rn*, mc-rfile (stepn (*s*, strncpy-t1 (*i*, *n*))))
= **if** d3-7a2-5p (*rn*) **then** read-rn (*oplen*, *rn*, mc-rfile (*s*))
else head (rn-saved (*s*), *oplen*) **endif**)

THEOREM: strncpy-s0-sn-mem-base1
(strncpy-s0p (*s*, *i**, *i*, *str1*, *n*_, *lst1*, *str2*, *n2*, *lst2*, *n*)
$\wedge$ (get-nth (*i*, *lst2*) = 0)
$\wedge$ disjoint (*x*, *k*, *str1*, *n*_))
$\rightarrow$ (read-mem (*x*, mc-mem (stepn (*s*, strncpy-t1 (*i*, *n*))), *k*)
= read-mem (*x*, mc-mem (*s*), *k*))

```
; base case 2: s0 --> sn, when lst2[i] =\= 0, n-1 = 0.
```

THEOREM: strncpy-s0-sn-base2
(strncpy-s0p (*s*, *i**, *i*, *str1*, *n*_, *lst1*, *str2*, *n2*, *lst2*, *n*)
$\wedge$ (get-nth (*i*, *lst2*) $\neq$ 0)
$\wedge$ ((*n* $-$ 1) = 0))
$\rightarrow$ ((mc-status (stepn (*s*, 9)) = 'running)
$\wedge$ (mc-pc (stepn (*s*, 9)) = linked-rts-addr (*s*))
$\wedge$ (read-dn (32, 0, stepn (*s*, 9)) = *str1*)
$\wedge$ mem-lst (1,
str1,
mc-mem (stepn (*s*, 9)),
*n*_,
put-nth (get-nth (*i*, *lst2*), *i*, *lst1*))
$\wedge$ (read-rn (32, 14, mc-rfile (stepn (*s*, 9))) = linked-a6 (*s*))
$\wedge$ (read-rn (32, 15, mc-rfile (stepn (*s*, 9)))
= add (32, read-an (32, 6, *s*), 8)))

THEOREM: strncpy-s0-sn-rfile-base2
(strncpy-s0p (*s*, *i**, *i*, *str1*, *n*_, *lst1*, *str2*, *n2*, *lst2*, *n*)
$\wedge$ (get-nth (*i*, *lst2*) $\neq$ 0)
$\wedge$ ((*n* $-$ 1) = 0)
$\wedge$ (*oplen* $\leq$ 32)

$\wedge$ d2-7a2-5p (rn))
$\rightarrow$ (read-rn ($oplen$, rn, mc-rfile (stepn (s, 9)))
= **if** d3-7a2-5p (rn) **then** read-rn ($oplen$, rn, mc-rfile (s))
else head (rn-saved (s), $oplen$) **endif**)

THEOREM: strncpy-s0-sn-mem-base2
(strncpy-s0p (s, $i*$, i, *str1*, $n\_$, *lst1*, *str2*, *n2*, *lst2*, n)
$\wedge$ disjoint (x, k, *str1*, $n\_$)
$\wedge$ (get-nth (i, *lst2*) $\neq$ 0)
$\wedge$ (($n - 1$) = 0))
$\rightarrow$ (read-mem (x, mc-mem (stepn (s, 9)), k) = read-mem (x, mc-mem (s), k))

```
; induction case:  s0 --> s0, when lst[i] =\= 0, n-1 =\= 0.
```

THEOREM: strncpy-s0-s0
(strncpy-s0p (s, $i*$, i, *str1*, $n\_$, *lst1*, *str2*, *n2*, *lst2*, n)
$\wedge$ (get-nth (i, *lst2*) $\neq$ 0)
$\wedge$ (($n - 1$) $\neq$ 0))
$\rightarrow$ (strncpy-s0p (stepn (s, 5),
add (32, $i*$, 1),
$1 + i$,
str1,
$n\_$,
put-nth (get-nth (i, *lst2*), i, *lst1*),
str2,
n2,
lst2,
$n - 1$)
$\wedge$ (read-rn (32, 14, mc-rfile (stepn (s, 5)))
= read-rn (32, 14, mc-rfile (s)))
$\wedge$ (linked-a6 (stepn (s, 5)) = linked-a6 (s))
$\wedge$ (linked-rts-addr (stepn (s, 5)) = linked-rts-addr (s))
$\wedge$ (rn-saved (stepn (s, 5)) = rn-saved (s)))

THEOREM: strncpy-s0-s0-rfile
(strncpy-s0p (s, $i*$, i, *str1*, $n\_$, *lst1*, *str2*, *n2*, *lst2*, n)
$\wedge$ (get-nth (i, *lst2*) $\neq$ 0)
$\wedge$ (($n - 1$) $\neq$ 0)
$\wedge$ d3-7a2-5p (rn))
$\rightarrow$ (read-rn ($oplen$, rn, mc-rfile (stepn (s, 5)))
= read-rn ($oplen$, rn, mc-rfile (s)))

THEOREM: strncpy-s0-s0-mem
(strncpy-s0p (s, $i*$, i, *str1*, $n\_$, *lst1*, *str2*, *n2*, *lst2*, n)
$\wedge$ disjoint (x, k, *str1*, $n\_$)

$\wedge$ (get-nth (i, *lst2*) $\neq$ 0)
$\wedge$ ((n − 1) $\neq$ 0))
$\rightarrow$ (read-mem (x, mc-mem (stepn (s, 5)), k) = read-mem (x, mc-mem (s), k))

```
; put together. s0 --> exit.
```

THEOREM: strncpy-s0-sn
let *sn* **be** stepn (s, strncpy-t2 (i, n, *lst2*))
in
strncpy-s0p (s, *i**, i, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, n)
$\rightarrow$ ((mc-status (*sn*) = 'running)
$\wedge$ (mc-pc (*sn*) = linked-rts-addr (s))
$\wedge$ (read-dn (32, 0, *sn*) = *str1*)
$\wedge$ mem-lst (1, *str1*, mc-mem (*sn*), *n_*, strncpy1 (i, n, *lst1*, *lst2*))
$\wedge$ (read-rn (32, 14, mc-rfile (*sn*)) = linked-a6 (s))
$\wedge$ (read-rn (32, 15, mc-rfile (*sn*))
= add (32, read-an (32, 6, s), 8))) **endlet**

THEOREM: strncpy-s0-sn-rfile
(strncpy-s0p (s, *i**, i, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, n)
$\wedge$ d2-7a2-5p (*rn*)
$\wedge$ (*oplen* $\leq$ 32))
$\rightarrow$ (read-rn (*oplen*, *rn*, mc-rfile (stepn (s, strncpy-t2 (i, n, *lst2*))))
= **if** d3-7a2-5p (*rn*) **then** read-rn (*oplen*, *rn*, mc-rfile (s))
else head (rn-saved (s), *oplen*) **endif**)

THEOREM: strncpy-s0-sn-mem
(strncpy-s0p (s, *i**, i, *str1*, *n_*, *lst1*, *str2*, *n2*, *lst2*, n) $\wedge$ disjoint (x, k, *str1*, *n_*))
$\rightarrow$ (read-mem (x, mc-mem (stepn (s, strncpy-t2 (i, n, *lst2*))), k)
= read-mem (x, mc-mem (s), k))

```
; the correctness of strncpy.
```

THEOREM: strncpy-correctness
let *sn* **be** stepn (s, strncpy-t (n, *lst2*))
in
strncpy-statep (s, *str1*, n, *lst1*, *str2*, *n2*, *lst2*)
$\rightarrow$ ((mc-status (*sn*) = 'running)
$\wedge$ (mc-pc (*sn*) = rts-addr (s))
$\wedge$ (read-rn (32, 14, mc-rfile (*sn*))
= read-rn (32, 14, mc-rfile (s)))
$\wedge$ (read-rn (32, 15, mc-rfile (*sn*))
= add (32, read-an (32, 7, s), 4))
$\wedge$ ((d2-7a2-5p (*rn*) $\wedge$ (*oplen* $\leq$ 32))
$\rightarrow$ (read-rn (*oplen*, *rn*, mc-rfile (*sn*))

$$
\begin{array}{lll}
 & & = \quad \text{read-rn}\,(\mathit{oplen},\ \mathit{rn},\ \text{mc-rfile}\,(s)))) \\
\wedge & ((\text{disjoint}\,(x,\ k,\ \mathit{str1}\,,\ n) & \\
 & \quad \wedge \quad \text{disjoint}\,(x,\ k,\ \text{sub}\,(\texttt{32},\ \texttt{8},\ \text{read-sp}\,(s)),\ \texttt{24})) & \\
 & \quad \rightarrow \quad (\text{read-mem}\,(x,\ \text{mc-mem}\,(\mathit{sn}),\ k) & \\
 & \qquad = \quad \text{read-mem}\,(x,\ \text{mc-mem}\,(s),\ k))) & \\
\wedge & (\text{read-dn}\,(\texttt{32},\ \texttt{0},\ \mathit{sn}) = \mathit{str1}\,) & \\
\wedge & \text{mem-lst}\,(\texttt{1},\ \mathit{str1}\,,\ \text{mc-mem}\,(\mathit{sn}),\ n,\ \text{strncpy}\,(n,\ \mathit{lst1}\,,\ \mathit{lst2}))) \ \textbf{endlet} &
\end{array}
$$

EVENT: Disable strncpy-t.

```
; some properties of strncpy.
; see file cstring.events.
```

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